Space Weather Technical Forecast

Issued on Monday, 16 September 2024 at 00:24 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

From the 24th of September, the way we distribute this forecast is changing and you will need to take action to continue receiving it. You should have received an email on the 4th of September explaining the steps required to do this. If you have already signed up to receive the forecast on our premium website, please disregard this message. If you haven't, or if you need help with the process, please contact moswoc@metoffice.gov.uk

Space Weather Forecast Headline: Chance of M-class flares. G1-G2/Minor-Moderate Geomagnetic storms expected 16 Sep, with a chance of G3/Strong storm intervals and slight chance of peak G4/Severe storm conditions due to a forecast fast CME arrival.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Low with only C-class flares observed. There are seven sunspot regions on the disc with the most active being AR3825 in the southeast with an X4.5 flare observed at 14/1529 UTC, although more recent flare activity has decreased. It is a compact region, now showing a reducing trend in both areal extent and magnetic complexity since the aforementioned flare, now having lost it's delta region. AR3824 continues with some weak spot/pore proliferation in the intermediate and trailing part of the group, including a single small spot of negative polarity, surrounded by a positive polarity region. A new moderately sized or large spot is emerging around the southeast limb, currently appearing as a simple Hsx, though may increase in complexity when it rotates clearly into view. The remaining regions are small, with limited magnetic complexity.

No Earth-directed CMEs have been observed.

Solar Wind / Geomagnetic Activity: Solar wind parameters, as observed by ACE at L1, were slightly enhanced during the period, with wind speeds gradually decreasing from elevated to slightly elevated, 450-550 km/s to 400-500 km/s. Density was below average throughout. The Interplanetary Magnetic Field (IMF) Bt, was steady, and mostly Weak to Moderate, between 6-9nT, while the north-south component, Bz, was erratic, but often negative, peaking -7nT at times throughout the 15 Sep. Phi angle was positive (away from the Sun). The net result of these parameters was for Quiet to Active geomagnetic activity (Kp 2-4).

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux observed by GOES18 has risen since the X4.5 flare, but remains below the S1/Minor Storm threshold at this time. High energy electron flux (greater than 2MeV) observed by GOES16, generally varied on a diurnal cycle between background to high, peaking at 1690pfu (High levels) at 15/1605 UTC. The associated 24-hour fluence showed a generally flat trend, with 5.8e7 integrated pfu observed at 16/0000UTC.

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Met Office Space Weather Technical Forecast

Four-Day Space Weather Forecast Summary

Solar Activity: Low to Moderate activity is forecast, with a chance of M-flares, most likely from AR3825.

Solar Wind / Geomagnetic Activity: There are up to two CME arrivals and up to two coronal hole fast winds which feature in the forecast. The most significant feature is the 14 Sep CME which may bring Strong or Very Strong solar winds at Earth on day 1 (16 Sep). This feature may have lingering effects into day 2 (17 Sep) combined with the first coronal hole fast wind. A second coronal hole fast wind may arrive day 3 or 4 (18 or 19 Sep), with slightly elevated to elevated speeds possible.

Generally Quiet to Active geomagnetic activity is expected initially. The 14 Sep CME should arrive by midday on day 1 (16 Sep) with G1-G2/Minor-Moderate storming expected, but a chance of peak G3/Strong storm levels and a slight chance of G4/Severe storm intervals occurring. These risks reduce into days 2 and 3 (17 and 18 Sep) due to waning CME and coronal hole fast wind effects.

Energetic Particles / Solar Radiation: High energy proton flux at GOES-18 has risen after the X4.5 flare on 14 Sep, but remains below the S1/Minor Storm threshold. There is still a chance that S1 proton storm levels may be reached day 1 (16 Sep), this risk reducing later in the period. High energy electron flux is expected to rise to diurnally Moderate to High levels ahead of the CME arrival from 14 Sep flare, reducing to mainly background levels thereafter. The associated 24 hour fluence is expected to remain below Active (1e8pfu integrated flux) threshold, with a steady, then declining trend.

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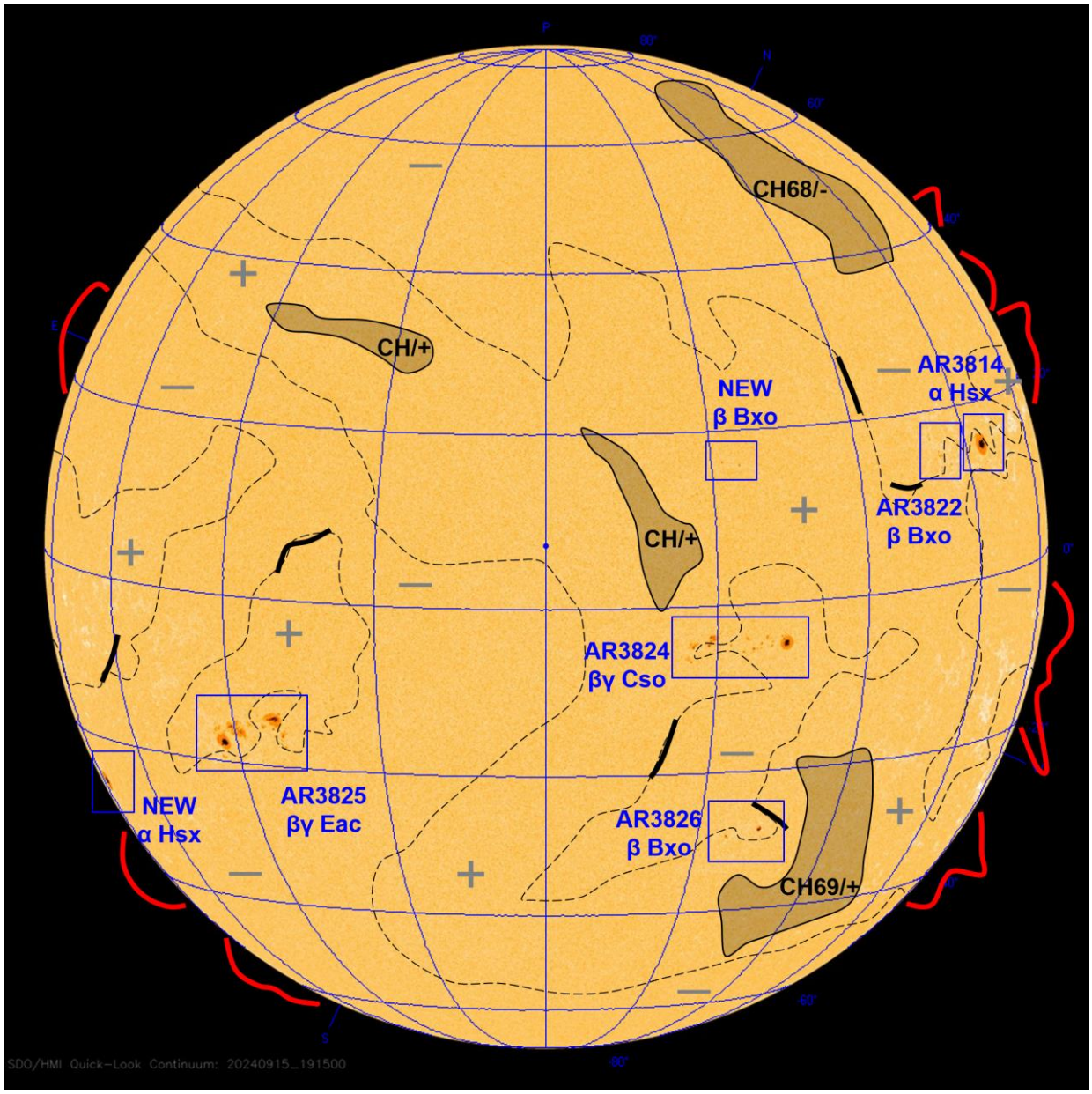
Figure 1. Solar Analysis Valid 15/1945UTC



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A CME was observed leaving the sun at around 13/0930 UTC, the result of a filament eruption, most likely associated with the M2.9 flare observed at 13/0835 UTC from AR3814. Its analysis revealed that the bulk of the ejecta is expected to pass ahead of Earth's orbit towards Stereo-A, however it may give a glancing blow on day 1 (16 Sep).

The most significant CME in the period originated from the X4.5 flare from AR3825 at 14/1528UTC. This spot was located around 55 degrees east at the time of the eruption, with subsequent analysis showing significant material being ejected directly away from the source in a narrow cone, but with a wider region of material also evident, this has been modelled with an arrival most likely during day 1 (16 Sep). There was also evidence of a faster shock visible beyond the opposing side of the Sun, giving clear Earth impacts from this shock also which may interact with Earth very early in the period before the bulk of the material arrives.

Aside from these arrivals, there are also up to two coronal holes which may influence the forecast. CH69/+ in the southwest may connect on day 1 (16 Sep). Confidence is low however, due to its southern location and Earth currently being above the solar equator in its orbit, though Enlil has consistently forecast strong solar winds (around 600km/s) from this feature. Finally, a small small positive coronal hole near centre disk may bring elevated wind speeds at Earth for a time. This is most likely to occur on days 3 or 4 (18 or 19 Sep).

Generally Quiet to Active geomagnetic activity is expected initially. The 14 Sep CME should arrive by midday on day 1 (16 Sep) with G1-G2/Minor-Moderate storming expected, but a chance of peak G3/Strong storm levels and a slight chance of G4/Severe storm intervals occurring. These risks reduce into days 2 and 3 (17 and 18 Sep) due to waning CME and coronal hole fast wind effects.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	80	60	20	20
Strong	G3	No	45	20	1	1
Severe	G4	No	15	5	1	1
Extreme	G5	No	5	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
14/1818	Partial	AR3825	SE	1250	16/0600-0800UTC	Large shock may arrive first, followed by material.

Figure 2: MOSWOC ENLIL

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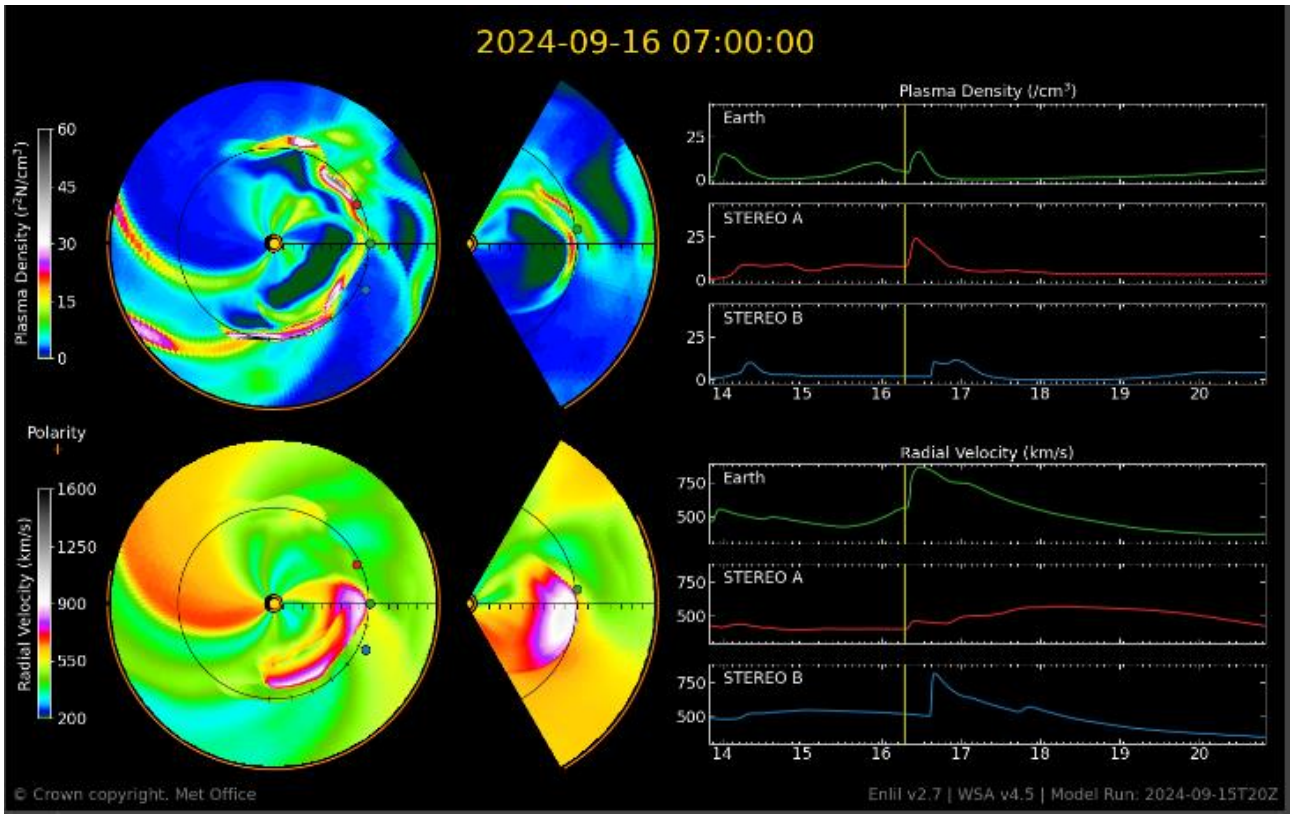

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Radio Blackouts - X-Ray Flares:

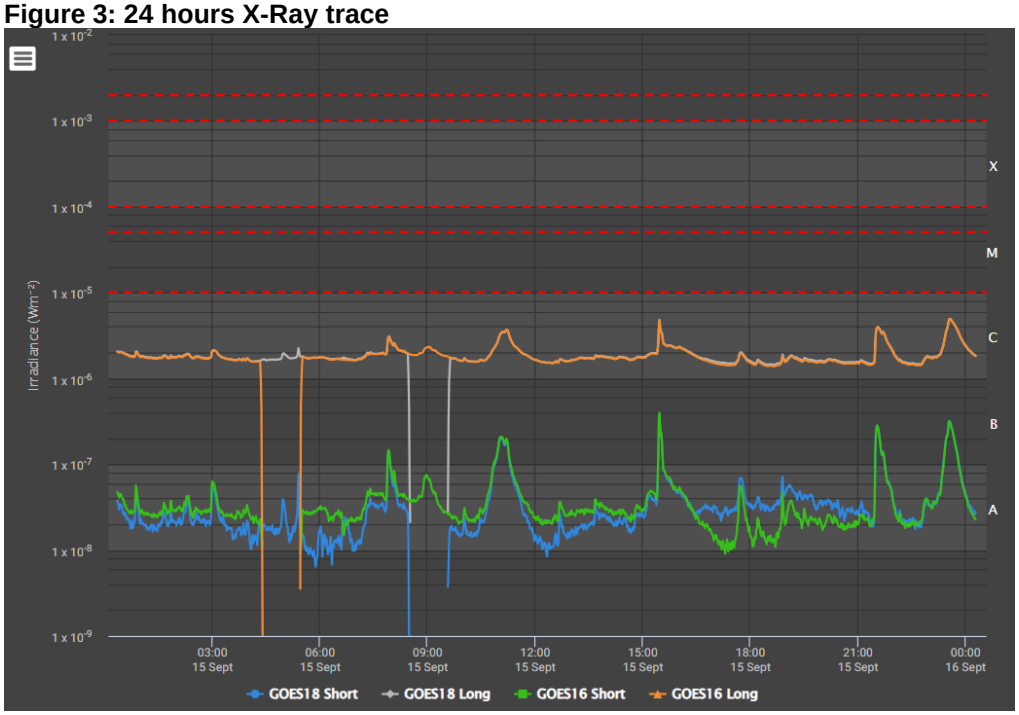
Activity has now fallen to Low with only C-class flares observed in recent hours.

There are seven sunspot regions on the disc with the most active being AR3825 in the southeast with an X4.5 flare observed at 14/1529 UTC, although more recent flare activity has decreased. It is a compact region, now showing a reducing trend in both areal extent and magnetic complexity since the aforementioned flare, now having lost it's delta region. AR3824 continues with some weak spot/pore proliferation in the intermediate and trailing part of the group, including a single small spot of negative polarity, surrounded by a positive polarity region. A new moderately sized or large spot is emerging around the southeast limb, currently appearing as a simple Hsx, though may increase in complexity when it rotates clearly into view. The remaining regions are small, with limited magnetic complexity.

There is a chance of further M-class flares, with a slight chance of isolated X-class flares, most likely from AR3825.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	40	40	40	40
Very Active	R3 to R5 X Class	Yes	10	10	10	10

Figure 3: 24 hours X-Ray trace



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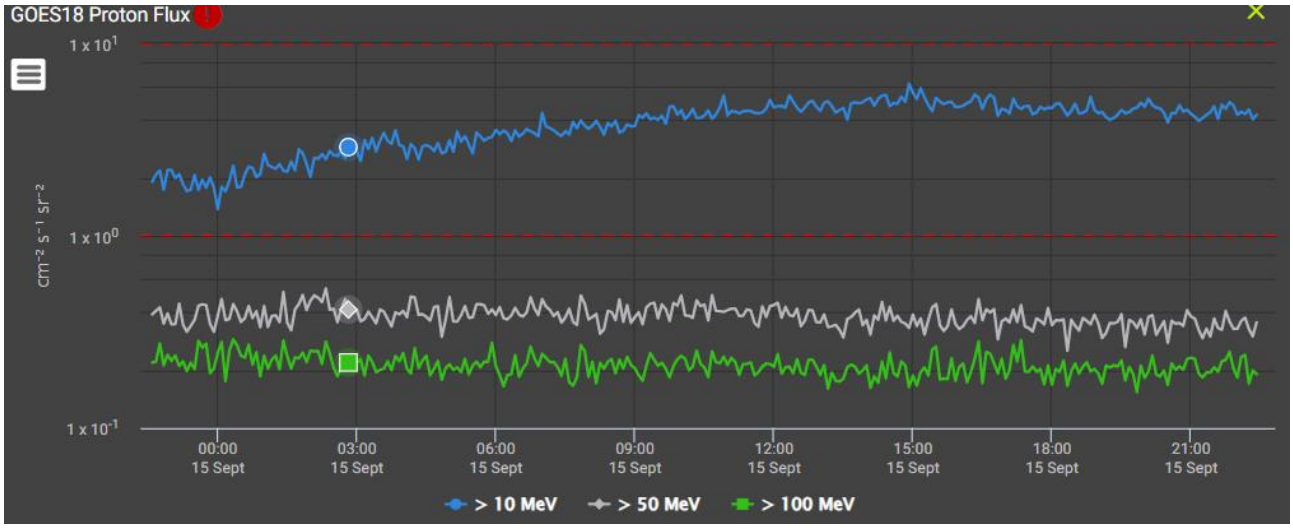
Solar Radiation Storms - (High Energy Protons):

High energy proton flux at GOES-18 has risen to moderate levels after the X4.5 flare on 14 Sep. A flat trend is now being observed, though there remains a chance that S1 proton storm levels may be reached day 1 (16 Sep) following the arrival of the 14 Sep CME, this risk reducing later in the period to a slight chance in the absence of any further notable flaring.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ S1	No	30	20	10	10
Very Active	≥ S3 *	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

Figure 4: 24 hour proton trace



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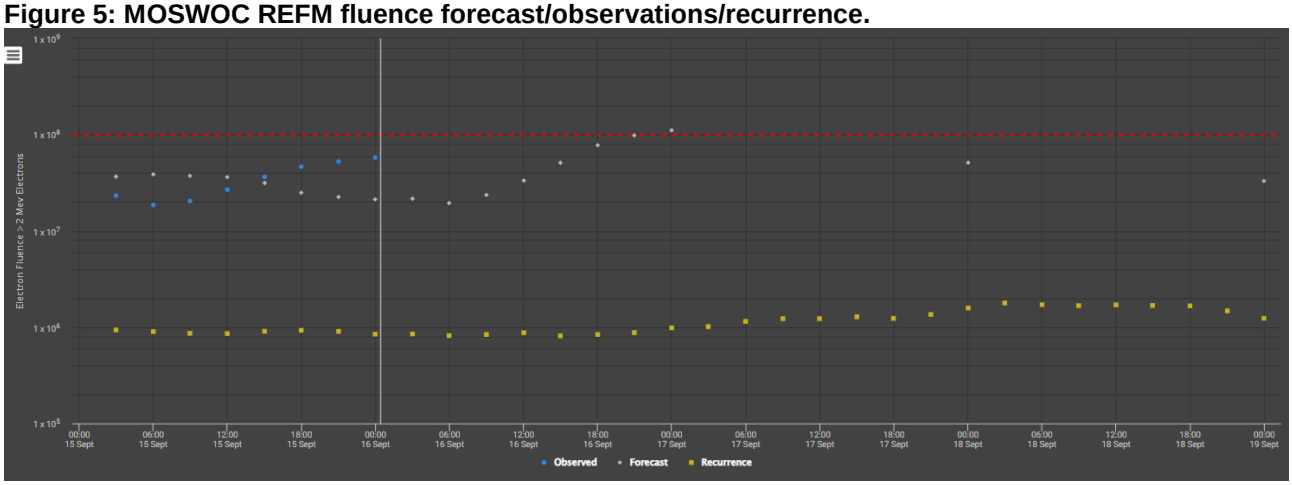
High Energy Electrons Event (≥ 2MeV):

The high energy electron flux has risen to High levels during the diurnal maximum due to recent geomagnetic storming that took place on 12 Sep. Now with up to two further CME arrivals anticipated and up to two coronal hole fast wind arrivals in the period, any rise is expected to be brief and the high energy flux most likely to return to mainly Background levels.

The associated 24-hour fluence is expected to remain below the Active level. The latest MOSWOC REFM output is currently showing a generally steady fluence forecast rise, however this isn't taking into account any CME impacts or possible coronal hole interactions in the coming days.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	20	5	1	1
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 5: MOSWOC REFM fluence forecast/observations/recurrence.



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